

# Merged high temporal resolution observations and satellite imagery of harmful algal bloom formation in Western Lake Erie

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**Motivation:** Satellite imagery and continuous in water measurements are merged to interpret patterns of harmful algal blooms (HABs) formation and senescence. Satellite imagery classified into optical water types (OWT) are used to identify water masses indicative of the HAB and other major flows of the basin to begin to understand the major drivers of HAB temporal and spatial distribution.

## Land/Ocean Biogeochemical Observatory (LOBO)<sup>1</sup>:

- LOBO was deployed in the summer of 2013 and 2014.
- Continuously observed chlorophyll, phycocyanin, CDOM, oxygen, phosphate, temperature, turbidity, and conductivity.

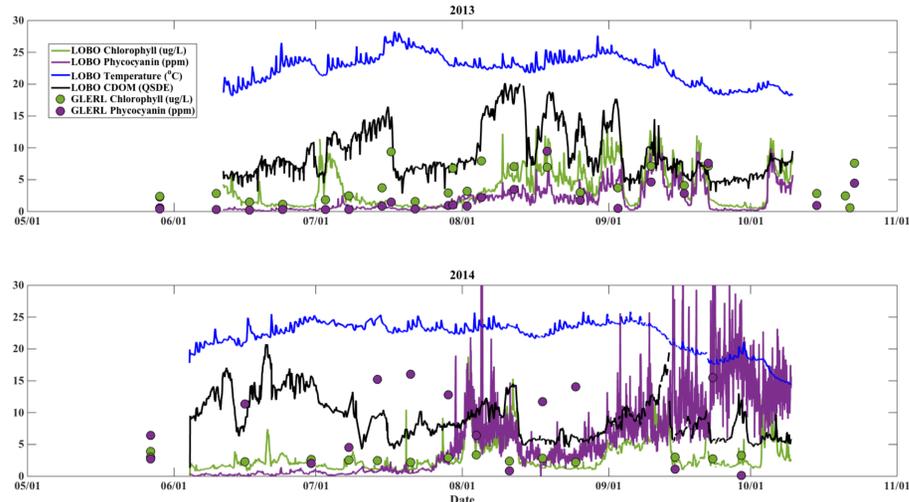


Figure 1. Select parameter LOBO observations every three hours and NOAA GLERL weekly observations at station WE2 for 2013 and 2014.

- CDOM and conductivity were strongly correlated and indicative of the water mass being sampled.
- [Chl] and phycocyanin were highly correlated during the bloom period.
- Clear relationships with phosphate did not exist.

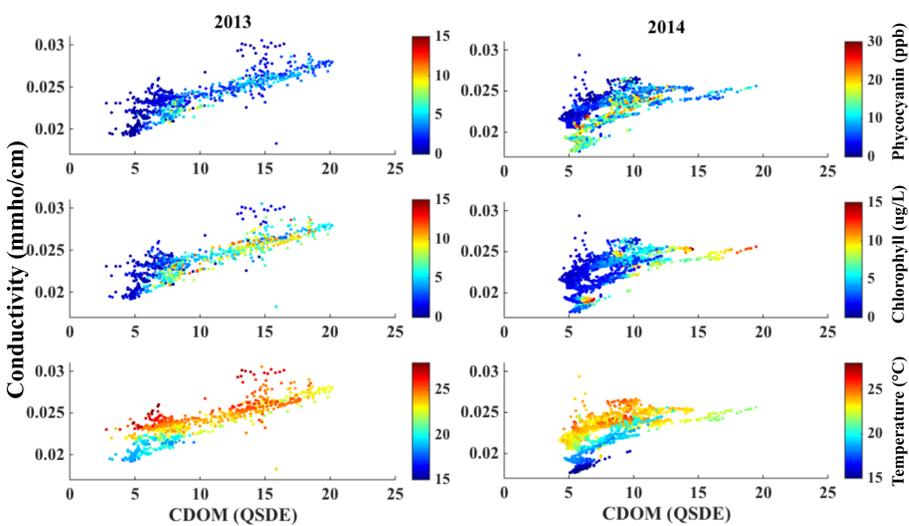


Figure 2. Conductivity vs. CDOM parameter space is used as an indicator of which water mass is being sampled. Phycocyanin, chlorophyll and temperature indicated in color for the bloom periods of 2013 and 2014.

- Satellite imagery classified into optical water types (OWT) are used to quantify spatial and temporal variability of the bloom to aid in determination of which water mass the LOBO is sampling at a given time.
- However, frequency imagery from polar orbiters do not capture the dynamic mixing and quiescent periods that determine the dispersion of the positively buoyant *Microcystis* cells throughout the water column; presenting challenges in interpretation.

## Optical Water Type (OWT) Classification<sup>2</sup>:

- Organized based on reflectance spectral mean features and varying [Chl]
- OWTs 1 through 5 indicate increasing [Chl], whereas OWTs 6 and 7 have lower mean [Chl] than OWT 5.
- OWTs 4 through 7 have greater backscattering than OWTs 1 through 3, indicating higher presence of particulate matter.

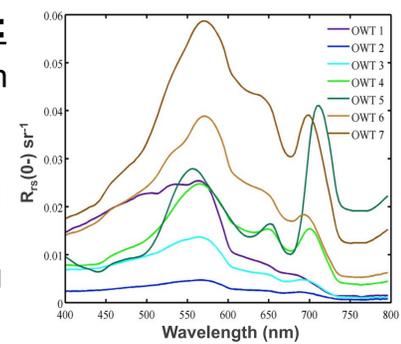


Figure 3. Mean  $R_{rs}(\lambda)$  for each OWT

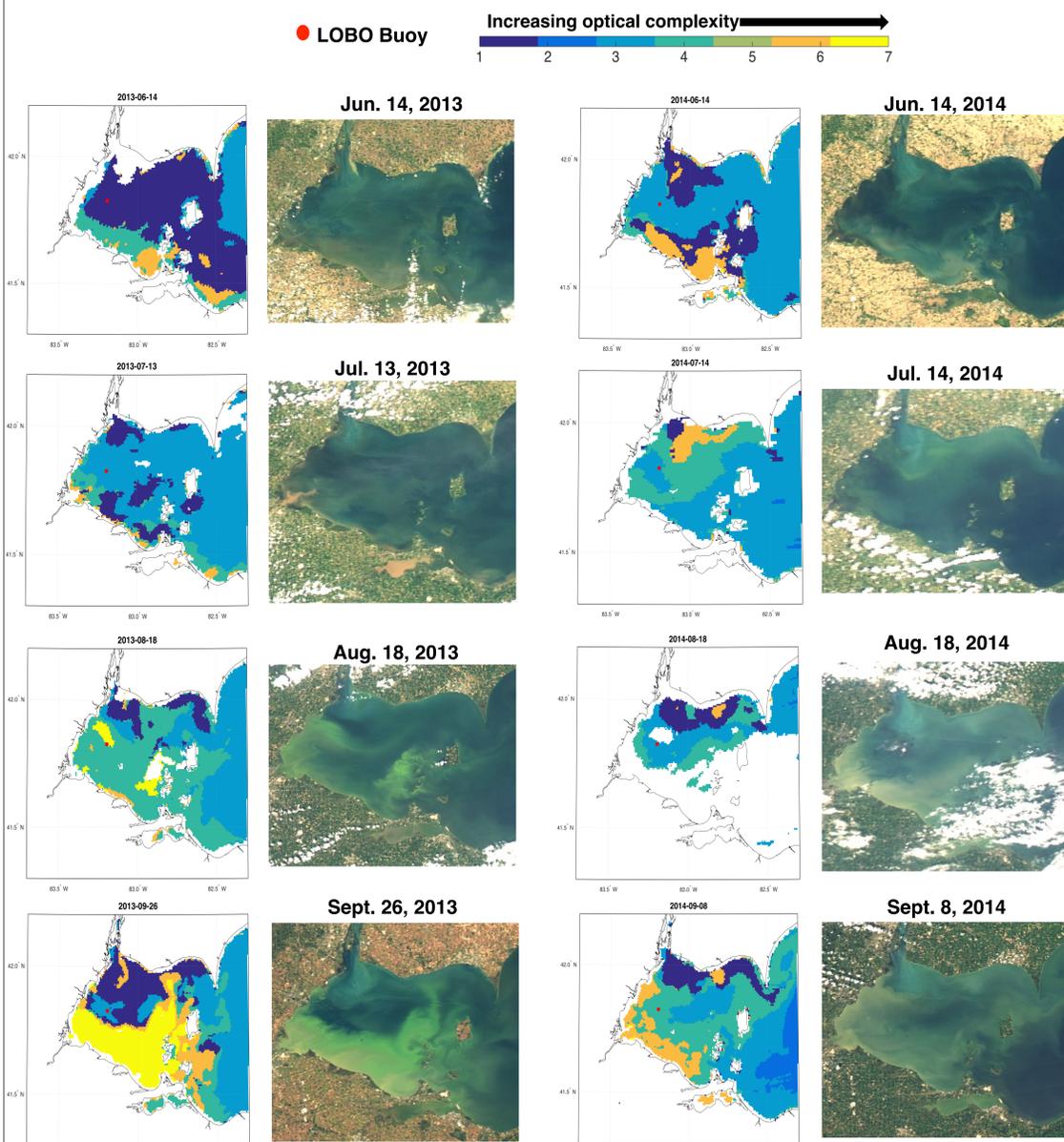


Figure 4. Select MODIS true color and classified optical water type images for 2013 and 2014.

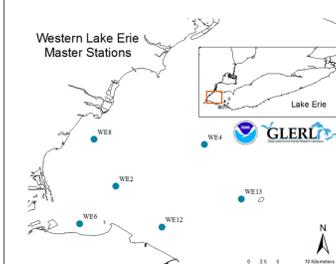


Figure 5. NOAA GLERL weekly sampling locations.

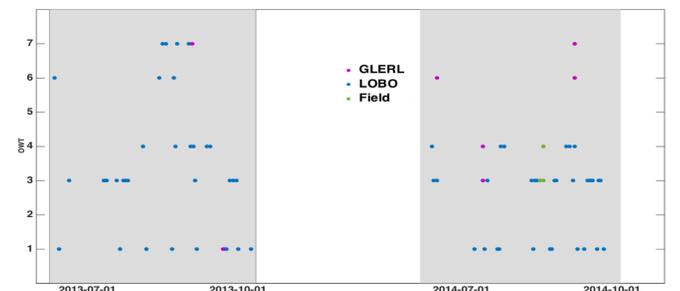


Figure 6. OWT matchups for all data sources in 2013 and 2014.

**Discussion:** Optical water type classification captures the HAB and riverine water masses movement in western Lake Erie. OWTs 1 and 3 appear to be associated with the Detroit River plume, while OWTs 4, 6, and 7 are associated with the Maumee River and the HAB. Of the 243 days sampled by the LOBO across 2013 and 2014, 40% had coincident MODIS imagery. Of the 247 stations sampled by NOAA GLERL and our own efforts, only 13% had coincident MODIS imagery. Mixing of positively buoyant *Microcystis* cells can dramatically change the optical characteristics of the surface waters within hours. A sensor on a geostationary platform would be far better suited to capture the dynamic nature of this system.